REPORT ON EXPERIMENT
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Experiment was carried out at:	**Local Contact**	**Proposal #**	***LANSCE Use Only***
X Lujan Manuel Lujan Jr. Neutron Scattering Center	Rex Hjelm	**9110**	**Report Rc'd**
WNR Weapons Neutron Research Facility	**Instrument Used**		
WNR/Blue Room	LQD		

Title: Neutron Radiography of Firing Set Housings

Authors and Affiliations: William Moffatt, Sandia National Laboratories; Thomas Rieker, University of New Mexico; Rex Hjelm, Tom McDonald, Los Alamos National Laboratory

Improvements in materials screening technology can have great practical significance for nuclear weapons programs. For example, the cost of molding materials and processing for firing set housings is low, but the value of a firing set can be around $250,000 when stuffed with components and potted. Furthermore, the integrity of the firing set housing can be basic to a weapon safety theme. Any improvement in our ability to detect housings with unsatisfactory properties early will result in improved weapon safety and lower weapons system cost.

The polymer/glass composite material used in the firing set housings studied here was manufactured under the trade name MXB-71 by Fiberite, Inc. It is a blend of polyamide-modified phenol formaldehyde polymer with 1/2" x 1/2" E-glass mats. E-glass contains 8-13 wt% B_2O_3. The firing set housings were fabricated by simultaneously hot-pressing several MXB-71 polymer/glass mat preforms in a metal die. Disturbed material might be expected at "weld lines", where material from different preforms flows together during the hot pressing operation. Ultrasonic characterization found areas with anomalous properties in locations consistent with "weld line" defects. Unfortunately, the spatial resolution of the ultrasound technique was poor, so we could get no detailed understanding of the microstructural state corresponding to the ultrasonic anomalies from this technique. The thick sections in the housing suggested the use of (highly penetrating) neutrons for microstructure characterization.

We studied defective and non-defective areas of a nuclear weapons firing set housing using small angle neutron scattering (SANS) to determine whether SANS would be a practical, useful technique for determining the state of health of the materials of construction of the housing. Diffraction studies of areas known or suspected to be defective showed some structure in the diffraction pattern; it was however, not possible to tie this in an unambiguous way to the quality of the material. It is plain from the results that small angle neutron scattering will not be useful in the role of a single analytical tool for characterizing the mechanical state of these housings. In spite of this, they seem to corroborate well the results of high resolution neutron radiographic studies of the same parts undertaken by Tom MacDonald of Los Alamos; the mechanical materials anisotropy apparent in the real space neutron radiographs matched the distortion of the reciprocal space image seen using SANS. **Figures 1 and 2** are macrographs of the samples tested.

Figure 1. Cracked section of firing set housing

Figure 2. Section of firing set housing containing uncracked but possibly defective regions ("weld lines)

Figure 3 below is the central region of a small angle neutron scattering x-y plot for the crack in the cracked section in the first picture above. The differences between this plot and that for uncracked areas nearby were negligible and could not serve as a guide to the quality of material for this sample. **Figure 4** below is a small angle neutron scattering x-y plot for the disturbed zone in one of the reentrant corners in the second picture above. The tilt of the lobes corresponds to the expected tilt based upon neutron radiographs appearing below. Thus we might be able to use the tilt of the lobes of the image as a guide to the mechanical texture of the sample; further experimentation would be required to confirm this.

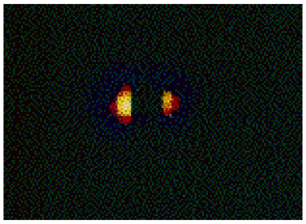

Figure 3. SANS of crack in sample in Figure 1.

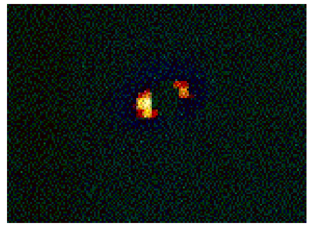

Figure 4. SANS of "weld line" in sample in Figure 2.

The neutron radiographs appearing in **Figures 5 and 6** below gave much more detailed and useful information on the state of the material than small-angle neutron scattering and is thus the technique we intend to pursue for further study of firing set housing materials when the beam comes back on line.

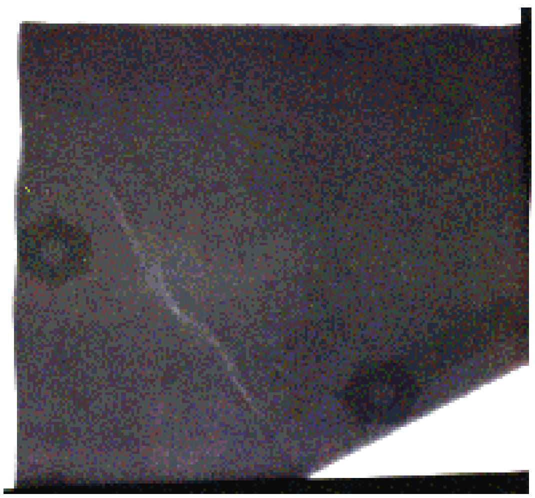

Figure 5. Neutron radiograph of crack in sample in Figure 1.

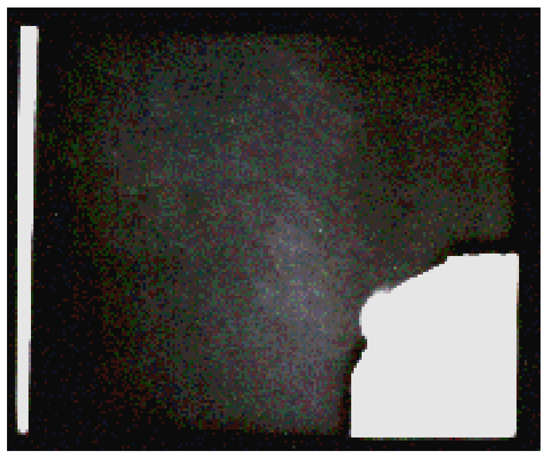

Figure 6. Neutron radiograph of possible "weld line" in sample in Figure 2.

List any publications resulting from this experiment (published or in press):

None for this portion of work done on experiment 9110

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[ ] Manuel Lujan Jr. Neutron Scattering Center	Ron Nelson	4N0087	Report Rc'd
[X] Weapons Neutron Research Facility	**FP/Instrument Used**		
[ ] WNR/Blue Room	FP30L		

Title
Experiments with a Large-Scale Ge Detector Array

Authors and Affiliations

J.A. Becker, M. A. Stoyer, L. A. Bernstein; Lawrence Livermore National Laboratory
R.O. Nelson, S. A. Wender; Los Alamos National Laboratory
N.R. Roberson, Duke University

Experiment Report

An experimental program is being developed to measure the ^{239}Pu(n,2n) cross section as a function of E_n. The proposed measurement is indirect: the cross section will be inferred from the partial γ-ray cross sections measured as a function of E_n. The link between partial and total cross sections is made with advanced Hauser-Feshbach theory, with corrections. Spectroscopy will be done with a large scale Ge detector array. A feasibility experiment was undertaken in Oct. 95. ^{238}U was used as a surrogate target, because the physics is similar to ^{238}Pu. Gamma-ray spectroscopy was done with two different γ-ray detectors: one detector was a planar HPGe detector, and the other a typical HERA coaxial HPGe detector.

The goals of the experiment were to:
- Test the feasibility of the proposed ^{239}Pu(n,2n) cross section measurement.
- Evaluate the γ-ray detectors under WNR experimental conditions.
- Bring together an experimental team

The experiment was a success. On-line analysis showed:
- Reaction γ-rays were observed above the background due to the fission competition.
- The signal to noise ratio is excellent.
- A complete set of γ-rays were observed, characteristic of even-even actinide nuclei. Gamma-rays from the ground state and vibrational bands were observed, and also from the quasiparticle states near 1 MeV excitation.
- The indirect technique is better the lower in excitation energy the γ-ray decays are observed because a larger fraction of the total cross section is measured. We observed the 4+-->2+ decay in this experiment, with E_γ = 104 keV. Observing a γ-ray this low in energy in a thick target experiment was unexpected.

- Planar detectors are crucial to the experiment because of the superior energy resolution at low energies and their relative insensitivity to neutron interactions.
- The precision γ-ray spectroscopy characteristic of Ge detectors allowed separation of ^{238}U γ-rays from the very similar (in energy) ^{236}U γ rays (produced in the n,3n) reaction.
- Excitation functions were obtained characteristic of the reaction, i.e., with the expected width and threshold behavior.
- No show stoppers were identified. The main problem to deal with in the ^{239}Pu(n,2n) experiment is increased fission and neutron production relative to the ^{238}U + n system.

References:

J.A. Becker, M.B. Chadwick, and R.O. Nelson, Measurement of the ^{239}Pu(n,2n) cross section between threshold and 15 MeV. (unpublished, 1995)

IMPORTANT! List or attach a list of publications resulting from this experiment (published or in press).

In-beam spectroscopy of the ^{238}U(n,xn) reaction at LANSCE, J.A. Becker, L.A. Bernstein, M.A. Stoyer, R.O. Nelson, S.A. Wender, and N.R. Roberson, Bull. Amer. Phys .Soc., May 1996.